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INTERDISCIPLINARY APPLICATIONS AND INTERPRETATIONS OF ERTS DATA WITHIN THE SUSQUEHANNA RIVER BASIN

Resource Inventory, Land Use, and Pollution

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16. Abstract

The major effort during the first six-month period of this investigation was devoted to continued development of a capability to receive, process, analyze, and interpret ERTS-1 data. Since the first digital data was not received until late in the reporting period, only a minimum amount of actual analysis was performed. Within twenty-four hours of receipt, the first digital tapes were submitted and intensity and uniformity computer maps were produced. A Mosaic ERTS image of Pennsylvania was constructed from imagery received to date. Aircraft underflights were flown in July and photographic data from these missions have been received.

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PREFACE

The major effort during the first six-month period of this investigation was devoted to continued development of a capability to receive, process, analyze, and interpret ERTS-1 data. Since the first digital data was not received until late in the reporting period, only a minimum amount of actual analysis was performed. Within twenty-four hours of receipt, the first digital tapes were submitted and intensity and uniformity computer maps were produced. A mosaic ERTS image of Pennsylvania was constructed from imagery received to date. Aircraft underflights were flown in July and photographic data from these missions have been received.

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I. INTRODUCTION

The major effort during the first six-month period of this investigation was devoted to continued development of a capability to receive, process, analyze, and interpret ERTS-1 data. Since the first digital data was not received until late in the reporting period, only a minimum amount of actual analysis was performed.

II. DATA PROCESSING DEVELOPMENT

Through experience with ERTS-1 and aircraft remotely sensed multispectral data, ORSER has developed an operational system for processing of both imagery and computer compatible tapes. The ORSER system for processing MSS digital tapes (See Borden, F. Y., Remote Sensing of Earth Resources, vol. 1, Tenn. Space Institute, University of Tenn, 1972) was developed for use by a wide variety of researchers in remote sensing at The Pennsylvania State University. These potential users represent many disciplines and have a wide range of experience and skill in computer usage.

The main computer is the IBM S/370 Model 165 which is dedicated to general university research and educational uses as well as to similar nonuniversity uses. Users may have access to the computer in any of three ways: (1) central and remote high speed dispatch points operated by the Computation Center, (2) slow speed Remote Job Entry (RJE) terminals using IBM 2741 or similar terminals supported by the user or by the Computation Center, and (3) intermediate speed remote batch terminals such as the IBM 2780 supported by the user or the Computation Center. The processing system for MSS data was developed to use any of these entry points. The RJE terminals are used for most developmental work. Bulk output for final runs is directed from an RJE terminal to any of the high speed terminal sites. The MSS data processing programs exist in library files in the computer so no program card decks need to be input. Files for building control information or storing output are available to the user. MSS data is input from magnetic tapes. The Computation Center manages the data tapes as well as user-owned work tapes. Nonuniversity users as well as university users may join the system, either locally or via long distance telephone lines.

A standard digital tape format was designed within which all known MSS sources could conveniently be placed. A tape file contains data for only one flight line. More than one file per tape is allowed as well as a continuation of a file to another tape. Within the file four kinds of records exist: (1) identification records, (2) table of contents record, (3) MSS response records, and (4) history records. Each MSS response consists of a complete scan line. Each scan line is numbered and scan lines are always in ascending order in a file. The table of contents record indicates the actual contents of the file. A working file will usually contain only a small part or parts of the whole data set for a flight line. The table of contents is particularly useful in such cases in avoiding costly searching for data which is not present in the file.

The system is couched in a multivariate framework. Although it is understood that some operations do not require this statistical basis, this approach is, overall, most appropriate. Each observation, identifiable by scan line and element number, consists of a vector with as many elements as there are channels. At present, each vector is composed of just MSS response values; however, it is anticipated that the vectors will be augmented by other nonscanner data such as topographic data or transformed scanner data.

The system is not in a conversational mode where the user and the system dynamically interact during the processing. Each program accepts input control specifications, processes the MSS data according to the specifications and outputs the results. The user prepares the control specifications for each program.

Although the system is non-conversational, the preparation of the control specifications by the user who is operating from an RJE terminal is conversational. For non-RJE operation, control specifications are made and entered into the system by punched cards. In RJE use, all control specifications are identical in format to the corresponding punched cards.

ORSER has set up a photo-interpretive laboratory with light tables and a stereoscope for handling 9" X 9" transparencies. A Bausch and Lomb stereoscope with zoom capability for handling 70mm transparencies has been ordered. A Bausch and Lomb Transferscope is being ordered. In addition, a completely equipped photogrammetry and photo interpretation laboratory in the Department of Civil Engineering at Penn State is available for use by ORSER personnel.

Procedures for handling and storage of both computer compatible tapes and imagery (for ERTS and aircraft) have been formalized and are attached as Appendices A and B of this report.

III. DATA ANALYSIS

The first ERTS imagery for an early August pass was received during this period. The Principal Investigator attended the briefing at GSFC on September 29 and while there, visited the browse facility with the scientific monitor, Dr. Harol Mathews. Imagery from the September 6 flight was viewed at that time. As a result of this visit, it was determined that the standing order be changed so that ORSER (Office for Remote Sensing of Earth Resources) would receive imagery for both bands 5 and 7 instead of just band 7 as originally requested.

During the period covered by this report, photography from C-130 flights in July and U-2 flights in April and June was received.

The first ERTS computer compatible tapes were received on October 30, 1972, for the frame 1027-15240 of 19 August 1972. Although most of the scene lies outside the area of this investigation (Susquehanna River Basin), it was decided to process that portion of the tapes covering a cloud-free area in southwestern New York State near Silver Lake. Since this was the first set of actual ERTS CCT's received, it provided an excellent test for the processing of ERTS digital data at Penn State. Within twenty-four hours, the tapes were subsetted and

intensity and uniformity computer maps were produced for the selected area. No difficulty was encountered in either locating the desired area on the tapes or in processing the data.

A mosaic ERTS image of Pennsylvania was constructed from imagery received to date. Though this mosaic contains some cloud-covered sections of the State, it is sufficiently clear to permit examination of areas larger than previously available in a single picture. The geology investigators in ORSER are examing this for fracture traces, lineaments, and other geologic conditions.

Photointerpretation techniques have also been applied to the ERTS-1 imagery. Of the equipment immediately available to ORSER to date the Saltzman projector appears to give the best overall image definition combined with rapid tracing of observed features. Upon delivery of the Bausch and Lomb Transferscope, ORSER's capability for image interpretation of ERTS will be enhanced considerably. Some preliminary results of work done with the Saltzman projector are shown in Table 1.

Table 1: Results of Photointerpretation of ERTS Imagery Using the Saltzman Projector.

Land Use Category	Channel 4	Channel 5	Channel 6	Channel 7	Preferred Channel
Drainge (Blue)	Incomplete. Islands obsured, Shorelines grade into forest.	Incomplete. Shorelines grade into forest.	Confused with urban.	Some confusion with urban.	Channel 7
Roads (Brown)	Very incomplete.	Clearly defined where white. Unreliable when parallel to scan lines. Many dark lines could be roads or drainage.	Rarely seen and poorly defined.	Rarely seen.	Channel 5
Urban (Black)	Grades into suburban.	Confused with probable bare fields. Otherwise fairly distinct.	Minor confusion with suburban and drainage.	Confused with drainage.	Channels 5 & 6
Suburban (Grey)	Not differentiable from urban. Confused with agriculture.	Not differentiable from agriculture.	Confused with agriculture.	Fair to poor distinction from both agriculture and urban.	All poor, due to confusion with agriculture.
Forest (Dark Green)	Not differentiable from drainage and often confused with agriculture.	Some confusion with drainage.	Confused with agriculture.	Confused with agriculture.	Channel 5
Agriculture (Light Green)	Confused with forest and often with suburban.	Not differentiable from suburban.	Confused with both forest and suburban.	Confused with forest and with portions of suburban.	All poor, due to confusion with forest and suburban.

IV. AIRCRAFT SUPPORT

We have had one underflight with the NC-130 on July 20 and 21. This mission was flown shortly after Hurrican Agnes and as a result there was considerable cloudiness over Pennsylvania. Therefore, much of the photography and imagery was of poor quality. However, in cloud free areas the photography and imagery were excellent. The time of the July flight was very close to our requested flight date.

Photographic data received from this flight was organized into flight lines. Within each flight line the photographic quality and scale was determined. Various features were identified and designated according to frame number. This information was catalogued for easy access by the user. A single channel of strip imagery was also received and used to select areas for converting into digital format. A request for computer compatible tapes and film imagery has been made to the Manned Spacecraft Center. Efforts were also expended on the coordination of a flight planned for January, 1973.

Photographic data collected by the U-2 aircraft was also received. This film was also inventoried and catalogued for easy user access. Plans were made for a January U-2 flight with the camera system and a four-channel multispectral scanner.

Discussions were undertaken with personnel from NASA, Wallops Island, to determine how our activities might be coordinated with their facilities. This effort would possibly involve the use of their C-54 aircraft and possible flightlines were discussed.

Since the only type of underflight data received to date has been photographic, it has been used for making comparisons with digital computer outputs of ERTS-1 imagery. The aircraft data is being used primarily as a form of ground truth.

V. PUBLIC RELATIONS

Several interviews of ORSER personnel on local radio and educational television stations have taken place. These were of an informational nature and primarily concerned the nature of ERTS data, and its potential applications. Specific analytical results were not discussed. Press releases were also prepared by the Office of Public Information at Penn State. These releases were sent to the various media throughout Pennsylvania, and in the case of several newspapers resulted in a print of an ERTS image containing the geographical area of local interest. As a result of the release of this information, ORSER has received inquiries regarding its activities from high school students and teachers, regional planning commissions, private individuals, etc.

VI. PROJECTED WORK

During the next reporting period, ORSER will process the CCT's of ERTS data and analyze the data as proposed in the various tasks of this investigation.

APPENDIX A

CATALOGUES FOR REMOTE SENSING DIGITAL DATA TAPES

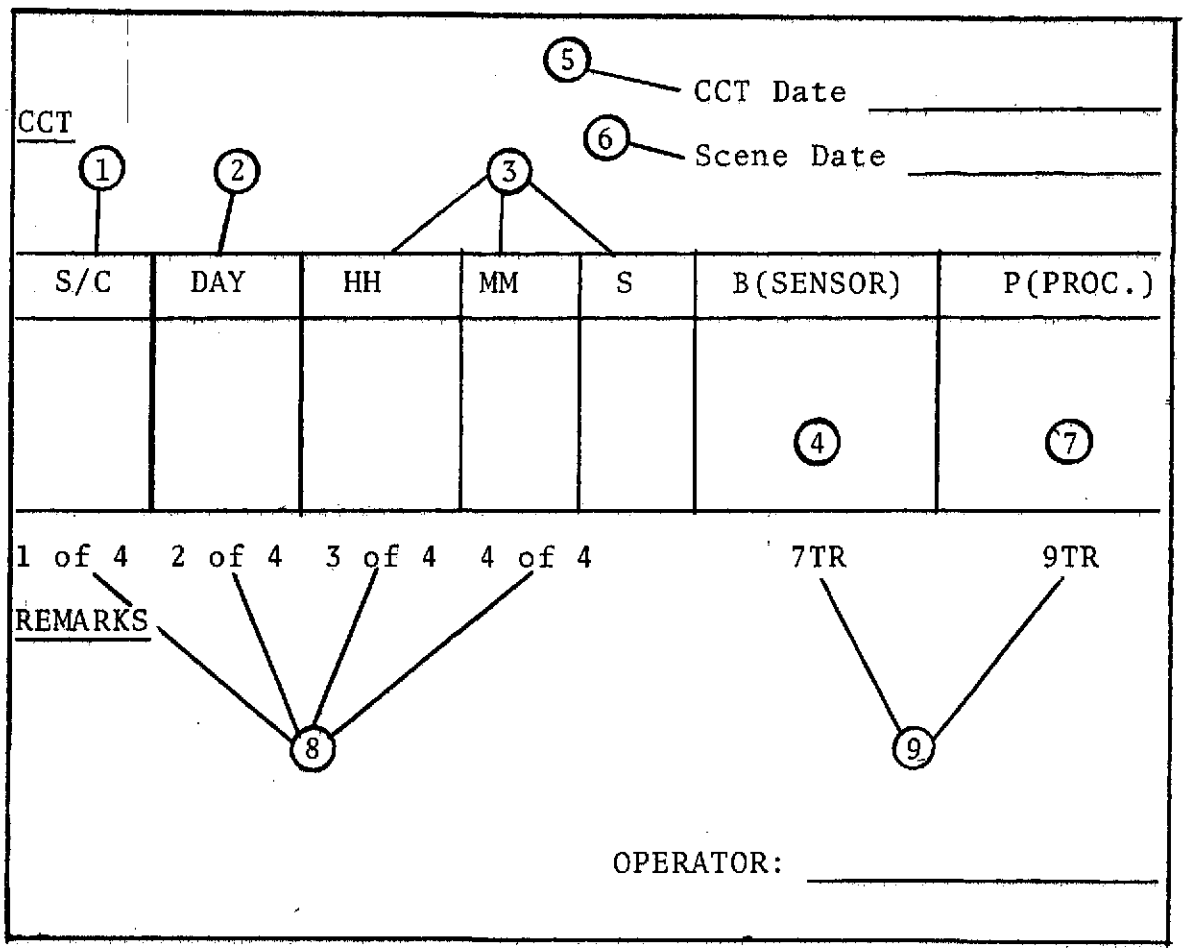
All remote sensing digital data tapes available to ORSER are catalogued and entered into a library. The cataloguing and submission to the library takes place as soon as possible after the receipt of tapes. The library has two sections, active and inactive. The active library section resides in the P.S.U. Computation Center and the tapes in that section of the library are managed by the Computation Center in accordance with their policies and procedures. The inactive library section resides in the ORSER facilities at 220 Electrical Engineering West Building. The inactive section is managed by ORSER personnel.

To meet with the Computation Center requirements, every tape in the active library has been assigned an external label which appears on the tape cartidge and reel. This will be called the ORSER external label henceforth. The assigned label must be used in computer processing in accordance with the Computation Center and ORSER program procedures. For convenience in use, each internally labeled tape has identical internal and external ORSER labels. A tape in the inactive library will have been assigned an ORSER external label if at any time the tape was in the active library.

The ORSER library is dominated by tapes containing satellite multispectral scanner data from the NASA-ERTS program. Tapes delivered to ORSER from the NASA-ERTS processing facility are referred to as NASA-ERTS tapes. Each NASA-ERTS tape is first entered into the inactive library. Depending on the quality of the data, the tape may remain in the inactive library or be transferred to the active library. For a NASA-ERTS tape entered into the active library, a comprehensive subset tape will be made as soon as possible, after which the NASA-ERTS tape may be returned to the inactive library. The comprehensive subset tape will remain in the active library.

NASA-ERTS tapes which have never been in the active library are catalogued according to the NASA external label. For these tapes, the NASA external label appears on the edge of the tape container as well as on the reel.

All NASA-ERTS tapes have the NASA external label affixed to the tape reel. The NASA external label for satellite data is described in Figure 1. All of the NASA-ERTS tapes and images for satellite data are in the bulk processed form. No precision processed satellite data has been ordered; however, the tape management procedures would be the same as for bulk processed tapes. The annotation on the bulk and precision processed imagery is organized differently. With regard to Figure 1, the



1 Satellite number. ERTS-A = 1.

2 The day (since launch) on which the observation was made.

3 Hour of day (HH), minute (MM), and tens of seconds (S).

4. Sensor code: R=RBV, M = MSS.

5 "CCT DATE" = Date the computer compatible tape (CCT) was generated.

6 "SCENE DATE" - Date of observation.

7 Processing code: P = Precision, B = Bulk.

8 Appropriate reel number will be circled by the operator.

9 Number of tracks will always be 9 for ORSER use.

Figure 1. NASA External Label.

cross-reference of NASA-ERTS tapes to the corresponding imagery is based on bulk processed data and imagery. The scene date, field number 6, in Figure 1 corresponds to the scene date field on the lower left corner of the imagery. The scene identification in fields 1, 2, and 3 of Figure 1 corresponds to the scene identification given on the lower right corner of the imagery. The reason the NASA external label scene identification cannot be used as the ORSER external label is that the number of digits is too large to meet the Computation Center's external label requirements. The catalogue of NASA-ERTS tapes incorporates the cross-reference feature described above. The detailed descriptions of the catalogues are presented later.

File Protection of Tapes

In the catalogues, file protection information for each tape is given. Three types of file protection exist for remote sensing data tapes: unprotected, partially protected, and positively protected. File protection governed by presence or absence of a file protection ring is not reliable because of conventions and procedures of the Computation Center. File protection is governed by the presence or absence of internal system labels on tapes and the retention date for internally labeled tapes. Tapes which have essentially

no protection have internal system labels without any retention date. Each one of these is protected only insofar as it can be accessed by reference to the correct internal label. Work tapes must be of this type in order to be able to accept output. Data which is valuable in that it would be very difficult or expensive to restore should not be kept on an unprotected tape.

Positive protection (date protection) can be gained by copying or outputting the data on a tape for which a JCL retention date has been specified. ORSER users should not use the date protection feature. For tapes that should be date protected, ORSER personnel will do it upon request.

An intermediate level of protection exists, called here "partial protection," and occurs only for tapes provided to ORSER from extra-university sources such as the NASA-ERTS tapes. Partial protection exists for internally labeled tapes in that access to such tapes can be gained only by specifying an unlabeled tape in the JCL. This occurs rarely in routine processing through the Computation Center. In addition, the external label would have to be given (by mistake) or the wrong tape mounted for the tape even to be made physically available to the computer.

Classification of Remote Sensing Data Tapes

Remote Sensing data tapes are classified into five categories as follows:

1. NASA-ERTS data tapes,
2. permanent subset data tapes from NASA-ERTS tapes,
3. ORSER users data tapes,
4. other data tapes used by ORSER, and
5. private data tapes.

Catalogues exist and are maintained for each of the first four categories. Tapes in these categories contain data which are available for use by any ORSER personnel. Remote sensing data tapes in category five are not considered to be available for use by ORSER personnel and as such are not entered into the ORSER tape library. Management of tapes in category five is the responsibility of the individuals to whom the tapes belong.

NASA-ERTS Data Tapes

NASA-ERTS data tapes in the active library are identified by an ORSER external label of the form NAcccc, where NA identifies the tape as a NASA-ERTS tape and cccc is the field which identifies the specific tape. These tapes are 9-track, unlabeled, 800 b.p.i. tapes and are partially file protected. They may not be used for output.

NASA-ERTS tapes in the active library contain substantial amounts of potentially useful data. Such tapes may be transferred to the inactive library after comprehensive subset tapes have been made from them. NASA-ERTS tapes which have no useful data; for example, because of 100 percent cloud cover, are not entered into the active library as a general practice and subsets from them are not routinely made.

NASA-ERTS tapes are in the format specified by NASA in "Earth Resources Technology Satellite, NASA Data Processing Facility, Format and Content Specification for Computer Compatible Tapes, May 1, 1972, Goddard Space Flight Center, Greenbelt, Maryland." They can only be read by the SUBSET program.

Permanent Subset Data Tapes from NASA-ERTS Tapes

It is expected that a permanent subset tape will be made for every NASA-ERTS tape which contains potentially useful data. The NASA-ERTS tapes are not intended to be used as the active data bases for routine use but rather as archives of data from which active data bases are prepared by subsetting. Therefore, before a user decides to use a NASA-ERTS tape, he should make certain that no suitable subset data tape is in the library. If none exists, then it would be necessary to generate such a

subset tape from the NASA-ERTS tape, but in doing so, the user should define the subset to be broad enough so that another subsetting from the NASA-ERTS tape does not have to be made.

Permanent subset data tapes from NASA-ERTS tapes will, in general, always be in the active library and are identified by an external label of the form SUcccc. SU identifies this category and the cccc field identifies the specific tape. They are 9-track, labeled, 1600 b.p.i. tapes and are date protected so they cannot be used for any other purposes then to contain these subsets. They are in the ORSER format and may be used directly with any programs in the system including SUBSET.

The contents of any of these tapes can be found be referring to the catalogue. These tapes usually arise as a result of subsetting a NASA-ERTS tape and are intended to be used instead of the NASA tape. The advantages of a permanent subset tape over the corresponding NASA-ERTS tape are: (1) the subset tape is in the ORSER format and can be used directly by any program in the system; (2) the 1600 b.p.i. density doubles the tape processing speed; and (3) where only scattered blocks of data are potentially useful on the NASA-ERTS tape, these have been consolidated on the subset tape thereby eliminating tape processing time devoted to bypassing useless data. If a permanent subset tape has been made,

the corresponding NASA-ERTS tape will not likely be in the active library.

ORSER Users Data Tapes

ORSER users data tapes are identified by RScccc, where RS identifies this category and the cccc field identifies the specific tape. These tapes are catalogued according to the data sets on them if such data sets are essentially permanent and of general utility to ORSER users. Others of these tapes are assigned to ORSER users as work tapes for the purpose of constructing and holding data subsets for their particular uses. Data sets on any of these tapes are considered to be available for use by anyone in ORSER. They may not be reserved for strictly private data sets.

Other tapes in this category may come about as the result of subsetting aerial flight tapes such as LARS data tapes. In such cases the subsetting is done to acquire a working copy of an original, to put the data in the ORSER format, to gain data protection, and to take advantage of 1600 b.p.i. density.

After a user has developed a subset of data on one of his assigned tapes which would be general interest to other users and which would not be subject to major changes, he should have the tape catalogued according to

its contents. ORSER users tapes may or may not be file protected at the discretion of the user in consulation with ORSER personnel.

Other Data Tapes Used by ORSER

Other remote sensing data tapes which are available for use by ORSER personnel are in either the active or inactive library and each may contain remote sensing data from one of a variety of sources. Examples of such tapes are the Bendix flight tapes and LARS data tapes. These are catalogued according to their contents but these is no particular uniformity in the external labels except that they are not labeled as any of the above categories. The tapes may or may not be in the ORSER format, but in general they can be read by the SUBSET program using the appropriate control cards. Data on these tapes are available to all ORSER users, but frequently permanent subset tapes have been made from them and these should be preferred for use. The reasons are stated in an earlier section. When permanent subsets exist, they are indicated in the catalogue. The catalogue for these tapes indicates whether imagery or aerial photography exists which corresponds to the data on tape and if so where it can be located.

Private Data Tapes

Users' other private data tapes are the users' own concern but they should not be labeled as any of the above categories to avoid confusion. They are not catalogued unless the user requests it under which conditions the data must adhere to one of the acceptable formats and must be assumed to be available to any other ORSER users.

Detailed Data Set Information

The detailed data set information sheets for data tapes which are of general interest form the Tape Detail Catalogue. If original data tapes have a corresponding complete permanent subset tape in the library, only the information sheet for the subset tape will be included. Information sheets for work tapes assigned to ORSER users will not be generally included. Users may obtain detailed tape and data set information for any catalogued tape by using the TPINFO program. The users should refer to the program write-up for specific details concerning use of the program.

Description of NASA-ERTS Tape Catalogue

The NASA-ERTS tapes are catalogued roughly in the order of the overpass of the satellite. The first

field in the catalogue line for a tape specifies the ORSER external label of the tape. The label appears on the cartridge and on the reel. If an ORSER label has not been assigned, the field will be blank and the NASA external label will apply. The NASA identification field gives the NASA external label in the form and content expressed in Figure 1. This identification corresponds to the image identification. Four reels of tape are required for each scene. Each reel corresponds to a 25 n. mi. wide strip 100 n. mi. long in a north to south orientation. The reels are numbered from west to east. The date of the overpass is given next. The status field indicates whether the tape is in the active or inactive library. The active library is at the Computation Center. Any tape in the active library can be directly accessed by the user programs by specifying the tape label in his control information. The inactive library resides in the ORSER facility at 220 Electrical Engineering West Building. Tapes in the inactive library cannot be accessed directly by programs, but must first be entered in the active library. ORSER will do this for users on request.

The alternate tape reference field indicates whether a subset has been made of all the potentially useful data from the NASA-ERTS tape or not. If such a subset has been made, the tape label for that subset tape will be specified in the field, otherwise, the field will be blank.

Permanent subset tapes will generally be made and recommended as alternatives to the NASA-ERTS tapes for the NASA-ERTS tapes which contain any data worthy of investigation. Subsets will not exist for NASA tapes for which cloud cover was essentially total.

The imagery-available field specifies whether or not imagery for the scene has been received by ORSER. If imagery has been received, a copy for one or more channels will be in the imagery section for cross-reference purposes.

NASA-ERTS tapes are only partially file protected as indicated by the next field. The two date fields are self-explanatory.

Description of the Image-Tape Cross-Reference Catalogue

The catalogue contain image copies of ERTS images is of particular value to users of such data. One of the channels is copied for each available scene with added reference information which applies to the tape data sets. The quality of the image is unimportant in this use. The images are marked to show the four 25 n. mi. by 100 n. mi. strips and the external labels of the corresponding tapes. Then permanent subsets have been made, the areas in each subset are marked and the external label of the subset tape if given.

Description of the Permanent Subset Tape Catalogue

The catalogue of permanent subset tapes from NASA-ERTS tapes is organized, in general, in the same way as for the NASA-ERTS tapes. Only the differences will be discussed here. The tape level always has SU as the first two characters. The subset source field is for reference to the NASA-ERTS tape or subset tape from which the subset was made. The retention date field specifies the date to which the tape remains positively file protected. If the field is blank, the tape is unprotected. The rest of the information follows the same specifications as apply to NASA-ERTS tapes.

The Imagery-Tape Cross-Reference Catalogue shows the general areas included in the subset for each of these subset tapes.

Description of the Tape Detail Catalogue

The tape detail catalogue gives the specific information for each of the tapes in the library except for work tapes and inactive NASA tapes. The item of major importance for each tape in this catalogue is the table of contents giving the line and element specifications for each block of subset data on the tape.

Description of the ORSER Users' Data Tape Catalogue

The first field in the catalogue line for a tape specifies the ORSER label for the tape. All tapes in this catalogue have RS as the first two letters of the ORSER label. The next field states the name of the user to whom the tape was assigned. If the name "ORSER" is given, the tape is a permanent subset tape of general interest to ORSER users. Tapes that were initially assigned to a specific user and contain subsets of general interest are reassigned to "ORSER" at the users request or when the user becomes inactive in ORSER.

The subset source field designates the identification of the tape from which the present tape was generated. An ORSER label is given if such exists and, if not, another appropriate label is given as used in one of the catalogues. The collection date field refers to the day, month, and year the data was collected except for NASA satellite data. In this case, the NASA external label will be given since it is the collection date as well as the scene identification. The status field indicates whether the tape is in the active or inactive library.

The imagery-reference field gives information concerning the availability and location of supporting imagery. For NASA-ERTS satellite data, a copy of one or more channels of the corresponding imagery is present

in the Image-Tape Cross-Reference Catalogue. The remaining two fields are the same as described in the previous section.

Description of the Other Remote Sensing Data Tape Catalogue

The catalogue is organized to have one tape description per page. The upper part of each page follows the field descriptions of the previous section. The lower part of each page contains a more comprehensive description according to the headings than is possible by filling in blanks and is self-explanatory. For users who submit data tapes to the library in this category, it is extremely important that these sections be filled in with as much detail as possible. Whenever other documents or publications can be referred to for more detail, they should be stated, but not instead of description requested on the form.

APPENDIX B

STORAGE AND HANDLING OF ERTS AND UNDERFLIGHT IMAGERY DATA IN ORSER

The Laboratory

All ERTS and underflight images are stored in the ORSER laboratory, Room 218 Electrical Engineering West. Computer tapes not in current use are stored in a separate room nearby, where they are kept on shelves in order of date and exposure time number.

The laboratory contain two closets, one for internal publications (e.g., technical reports, descriptions of computer programs for map generation) and one for the storage of film rolls. These is a file cabinet in which are kept packing slips from imagery shipments, miscellaneous information about images and flights (e.g., flight logs), 35mm slides of imagery and diagrams explaining imagery generation, and hand-out materials which have been used in seminars or for general information to the public.

Two map cabinets contain map coverage for all tracks of low altitude underflights, in 7 1/2 or 15 minute quadrangle form. Aeronautical charts and maps at a scale of 1:250,000 cover the entire state of Pennsylvania and parts of the surrounding states and Canada. There are drawers for outsized ERTS images (e.g., "blow-ups") and images mounted for display purposes or for stereographic study (e.g., underflight 9 X 9 inch frames).

Storage

ERTS images are stored in plastic page protectors in large three ring binders. They are filed in order of date, exposure time, and channel number. Black and white transparencies are filed first, then color composites, then contact paper prints. The first page in the binder is a copy of page 3-8 from the ERTS Data Users Handbook, explaining the alphanumeric annotation of bulk processed MSS images.

Images larger than 8 1/2 X 11 inch format (e.g., "blow-ups", framed color composites) are filed by date in a map drawer. Negatives in the 70mm format are kept in small 3 x 5 inch card file boxes, again filed be date, exposure time, and channel number.

Underflight film rolls are kept on shelves and arranged by flight line, and portion of the spectrum covered. All 70mm rolls which originally contained several flight lines have been separated into single flight lines and put on small reels, facilitating simultaneous usage by persons interested in different flight lines. Rolls of film in the 9 X 9 inch format have not been so divided, due to their bulk and a limitation in storage space.

Individual frames, or pairs of frames (i.e., for stereo study) are filed in a map cabinet, if 9 X 9 inch format, or in a 3 X 5 inch card file box, if 70mm format.

Retrieval

Information concerning ERTS and underflight data received by ORSER is kept in two large three-ring binders, blue for ERTS and red for underflights.

ERTS. As explained above, the first page of the ERTS KEY book explains the alphanumeric annotation of bulk processed MSS images. The second page is a table of statistics of ERTS and underflight imagery and MSS data, summarizing the altitude of the aircraft or satellite, type of sensors, portion of the spectrum covered, approximate "color" range covered by each portion, designation of each sensor, available study formats of the output, approximate area covered by one scene, approximate scale of the study formats in inches vs. miles and in ratio form, and the approximate ground resolution for each format.

Following the alphanumeric key and the table of data statistics, the ERTS Key book is divided by dates into section, one for each group of ERTS passes over Pennsylvania. For example, there is a section for September 4 through 8. The first page in this section is a base map of Pennsylvania, on which is plotted an outline of each scene for which ORSER has received imagery, with date and exposure time indicated. The second page in this section is an ozalid paper print made from the channel 7 transparency of the earliest scene available in the September 4 through 8 series. Key geographic elements can be determined from this print, and the extent of cloud cover can be observed directly. With this print is a cover sheet, indicating the format in which this scene is available for study (e.g., transparencies in various channels, color composites, "blow-ups", 70mm negatives, computer compatible tapes). There is a paper print and cover sheet of information for each scene within the September 4 through 8 sequence. The subsequent sections have the format described above. Each encompasses a series of passes comprising one complete coverage of Pennsylvania in five days.

The final section in the ERTS KEY book is a brief guide to the user of the ERTS Standard Catalogues and accompanying microfilm.

Underflights

The first page of the UNDERFLIGHT KEY book is a note informing potential users that additional information on underflights may be found in the file cabinet, filed under the specific flight type. The second page is a copy of the table of imagery statistics described in the ERTS KEY book discussion. The third page is an outline map of Pennsylvania on which are drawn flight lines for all underflight coverage of the state, to date, received by ORSER. Finally, in this initial section, there is an eight-page cross-reference table, listing geographic areas and their coverage by the various flights and the best ERTS images available.

After this preliminary section of the UNDERFLIGHT KEY book, the divisions of the book are according to flight type (primarily U-2 and C-130) and the seasons of flight.

The U-2 information consists primarily of a data book for each flight supplied by the Ames Research Center. The track maps provided at the back of each data book have been color-coded to indicate the presence or absence of clouds and haze; and frame numbers, at convenient intervals, have been added. Where flights cover areas in Pennsylvania. a separate annotation sheet has been prepared, indicating geographic locations in the state covered by the flight, and the frame numbers on the film from the various sensors on which that location may be seen. All U-2 flights are plotted on an outline map of Pennsylvania, which is the first page encountered in the U-2 section of the UNDERFLIGHTS KEY book.

The C-130 information in the UNDERFLIGHTS KEY book consists of a series of information summary sheets, followed by a separate annotation sheet for each flight line. The following summary information is provided: 1) An outline map on which is plotted all the flight lines for the season covered by the C-130 section under discussion; 2) A table of photographic information, indicating the portions of the spectrum covered by each camera, the film-filter combination used, the focal length, and similar information; 3) A key to the quality of the photography, primarily indicating the presence or absence of cloud cover and haze; 4) A chart listing the MSS channels used and the portion of the spectral band covered by each channel.

Individual annotation sheets for each flight line follow the summary pages, one for each flight line. Each sheet lists key geographic locations on the flight line, with frame numbers for each roll of film on which the location appears. The format of the photography, its scale, and the portion of the spectrum covered, are also indicated on each of these sheets for each roll on which the flight line appears. The final annotation sheet in this section lists the rolls of MSS images available, with frame numbers and flight lines covered.

Data from other underflights are recorded in a manner similar to that for the U-2 and C-130 flights, with adjustments of the format to conform to the information available and the nature of the data and flight.

Study Facilities Available in the ORSER Laboratory

Two light tables, one with film roll holders and a magnifying glass, are provided for the study of ERTS transparencies and underflight films, either 9 X 9 inch or 70mm rolls, or as individual frames. The film roll holders permit simultaneous viewing of two 70mm film strips, and are being reconstructed to permit simultaneous viewing of a 9 X 9 inch roll with a 70mm roll.

A Delft stereoscope and two mirror stereoscopes (one with a binocular attachment) are provided for the study of 9 X 9 inch stereo pairs. The Delft stereoscope and the mirror stereoscope with a binocular attachment permit viewing at two scales: 1.5X and 4X for the Delft and 1X and 6X for the mirror stereoscope.

A Bausch and Lomb 70 stereoscope is available for use with 70mm film, microfilm, or for detailed study of ERTS images. Single images may be viewed at from 10 to 120X using the single lens attachment. When this attachment is replaced by the rhomboid assembly, image pairs may be viewed in stereo in the 70mm format. The zoom feature of this unit permits viewing at any scale from 10 to 30X, with no adjustment of stereo fusion necessary during the continuous change in scale. To facilitate the handling of rolls of 70mm film, a pair of film reel holders have been constructed. These are attached to the small light table base of the instrument, one on each side. The reel holder assembly of each can be moved forward and back to permit viewing of the top and bottom of the film strip.

A Bausch and Lomb Zoom Transferscope has been ordered. This instrument permits projection of opaque or transparent images onto a plain surface or another image, with the capability of magnification in any direction, and selectively in a single direction, from 1 to 7X. This instrument will make it possible to project a photograph onto a computer generated map, with adjustment for the line and element distrotion inherent in the computer output.